CHINOOKS AND SUMMER FALLOW

Southern Alberta's Tragic Combination

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Over the years, Southern Alberta has put up with plagues, infestations, droughts, hail storms, and a host of natural phenomena all of which have challenged the ardour of the most committed of farmers. While these phenomena are devastating, they are nonetheless either short-lived, or are temporary, not constant problems. Wind, on the other hand, is almost a constant in Southern Alberta, and although it is seldom considered life threatening to the community, it is a major source of concern for farmers.

The warm, dry chinook wind which blows over the Rocky Mountains into Alberta steals moisture from the soil either by evaporating existing stores, or by sublimating potential supplies. Snowfalls are appreciated in the south, since they have the potential of melting into the soil and increasing the soil moisture content. The chinook, however, dries up the snow even before it has a chance to melt. To further aggravate the situation, once the snow has been removed, moisture loss from the soil surface is increased due to evaporation. Through capillary action, sub-surface soil moisture is drawn upwards and evaporated, bringing with it potentially undesirable chemicals which may impede the growth of crops and encourage salinity.

Once soil moisture has been depleted, the soil becomes highly susceptible to erosion. Water erosion, which is more prevalent in the Peace River District, does not pose a serious threat in Southern Alberta due to the relatively level slope of the land. Wind erosion, on the other hand, is quite another matter. Once the clods of soil break down, or become

pulverized underneath the wheels of a tractor or under foraging animals, the fine particles are easily picked up by the wind and carried great distances.

The effect of the windborne particles is analogous to the fine silt in a river. These particles are carried along, bouncing off the surface of a streambed, essentially sand-papering the rock below. In the air, these particles impact with clods of surface soil, breaking them down and in turn letting them be exposed to drifting. Following this train of thought, it becomes clear that the effect of erosion would become more serious further downwind since the amount of airborne sediment would increase to capacity and would have the potential for more damage.

This scenario was actually observed south of Calgary on April 20, 1986 when a strong westerly wind was blowing. The west-most portion of the field did not appear to be affected, but as one scanned the field to the east, the cloud of dust became more intense, sometimes with zero visibility. (Figures 1 and 2) The effect of the blowing wind was to strip the topsoil off the land, leaving behind exposed rocks which could do considerable damage to farm implements. Usually, such fine sediments choke rivers, fill roadside ditches, or even deposit on other fields damaging the land downwind. (Figure 3)

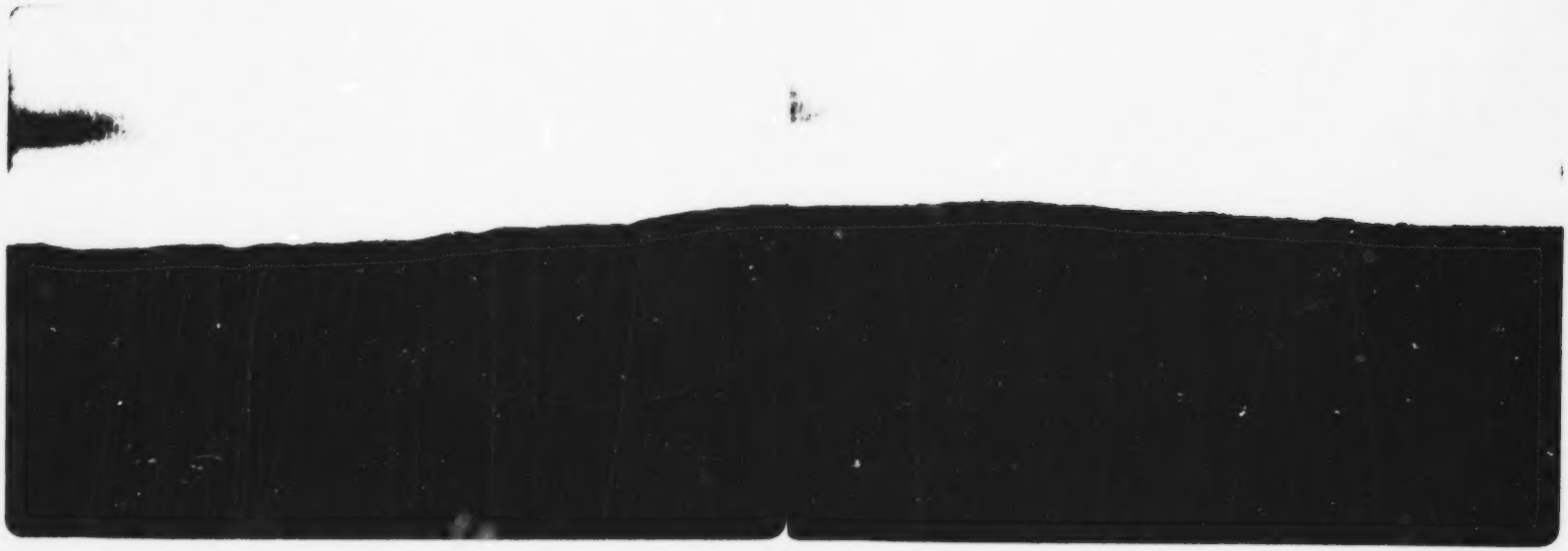
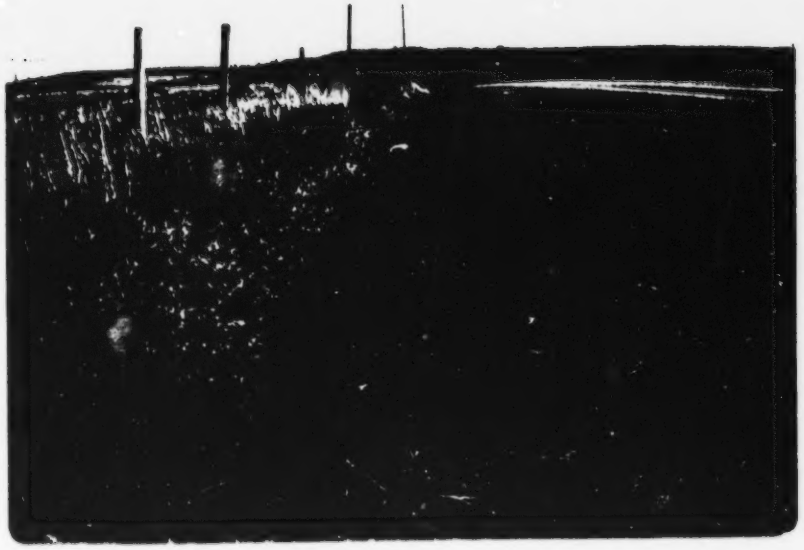


FIGURE 1. Location: South of Calgary off Highway 2.
Drifting is not evident on the far west portion of the field, but becomes more intense downwind.

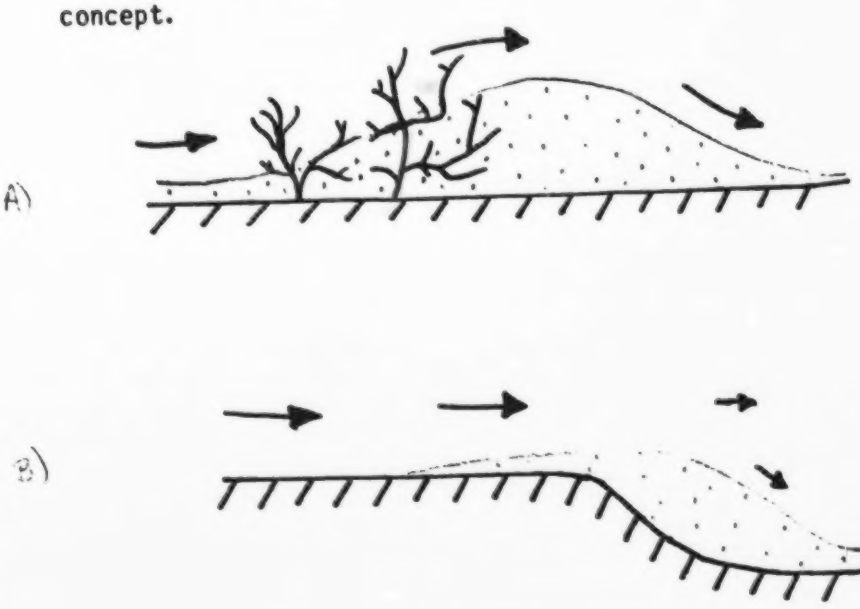
FIGURE 2. Location: South of Calgary off Highway 2. Visibility is very poor. Note the buildup of fine black soil in the ditch.

FIGURE 3. Location: Same as above. The fine silt has clogged the ditch on the other side of the eroded field. The pasture is also covered with the material.



In the case of south Calgary, the shrubbery on the east of the field served as a partial windbreak, and provided areas of decreased wind velocity on the leeward side where the capacity of the wind was effectively reduced, (Figure 4) depositing massive amounts of soil.

Even in areas without treed windbreaks, the slight depression of the roadside ditch was enough to allow: 1) the volume of air to expand; 2) the wind velocity to decrease, even if ever so slightly; 3) the capacity of the volume of air to decrease; and 4) the heavier sediment to deposit, sometimes to a depth of 18 inches, or 46 centimeters. (Figures 5, and 6A to 6D) As this deposit built up, the zone experiencing deposition began to shift downwind, increasing the size of the hummock. Diagram 1 illustrates this concept.

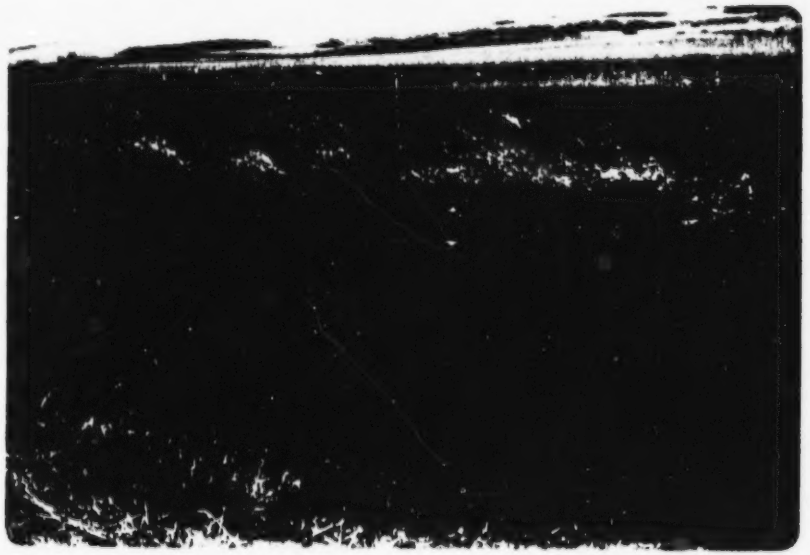


As the volume of air expands (B) the wind loses its ability to carry as much soil, and deposits it in the ditch.

Source: OKE, 1978, p. 217

FIGURE 4. (above) Location: South of Calgary off Highway 2. The low lying grasses are enough to trap a great deal of sediment. Note the ripples created by the wind in depositing the material.

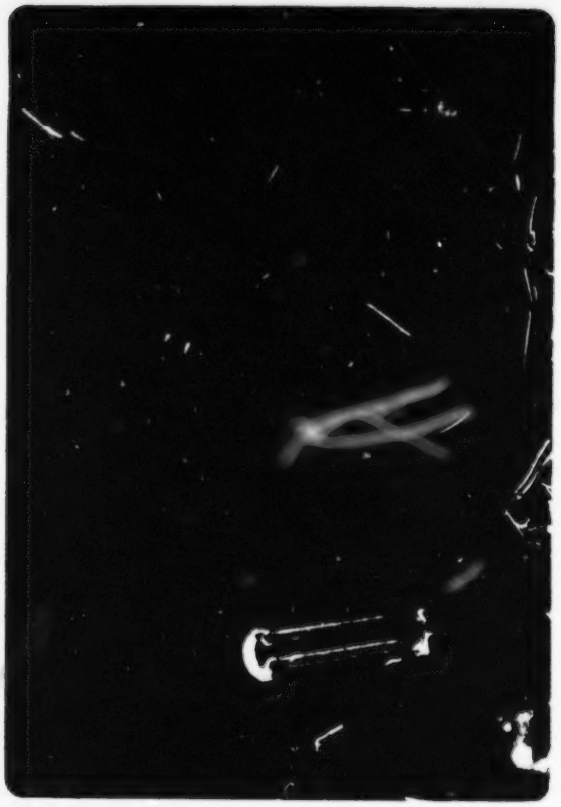
FIGURE 5. (right) Location: Same as above. There is a great load of sediment deposited in the ditch when the volume of air expands over the ditch.



A

B

FIGURES 6A to D. Location: South of Calgary off Highway 2.
The depth of the deposition varies, but in the area cleared, the vertical height was approximately 18 inches, or 46 cm.
Note in C and D (next page) the very obvious striations present. Further analysis of the layers may separate those strata which were laid down in gustier periods as opposed to more moderate winds. This would make a good study in geomorphology.



D

C

The removal of topsoil from such fields reduces the fertility of the soil for one basic reason: the organic matter is removed. Within the topsoil, or plow layer, is most of the organic matter which is the result of years of decay. This organic matrix improves the tilth of the soil, and supplies the soil with nutrients and minerals needed by the crops. Without the necessary organic and mineral fractions, fertilizers would have to be added to the soil at great cost to achieve equivalent effects.

A loss of topsoil also necessitates plowing into the less fertile horizons below. By mixing the fertile A horizon with the subsurface material, the resulting plow layer has less organic matter, poorer aeration, and an increase of non-soluable salts.

The effect of the loss of topsoil is best observed by examining the loss in terms of dollars and cents. In a study conducted in Lethbridge, Alberta in 1980, it was found that "after 22 years and 14 crops with added fertilizer, the productivity of a Dark Brown Chernozemic soil that had 20 cm of surface soil removed was not restored." (Lindwall, 1980) At 1980 prices, the loss of production amounted to $40 per hectare, and nutrients lost represented "an annual replacement cost to Canadian farmers of $15 - $30 per hectare." (McGill, 1982, p. 88)

In the beginning stages of erosion, this loss of production would not be readily observable since the applied fertilzier would masque the decline of

soil nutrients. However, over a period of several years, the effects would be felt in the form of increased use of fertilizer, and hence greater costs. According to a report on Soil Conservation by the Standing Committee on Agriculture, Fisheries, and Forestry to the Senate of Canada (1984), it would cost prairie farmers $239 million at 1982 prices to fully recover the loss of grain production from wind and water erosion. (Sparrow, 1984) It is evident that 'full recovery' of our agricultural resource would mean considerable expenditures especially at current (1986) prices and including degradation since 1984. I must hasten to add that doubtless, 'full recovery' does not mean that the soil quality and ensuing productivity will have been returned to its original virgin state. Once the topsoil has been removed, it takes several hundred years for nature to rebuild it. The often quoted average is one inch of topsoil on one hundred years, but this generalization fails to take into account climatic differences and variations in terms of temperature and precipitation. Nonetheless, extrapolation of the cost to recover production losses during the period it takes to rebuild the soil is in the billions of dollars.

It would seem to be logical to assume that the custodians of our agricultural resource base would maintain at the highest standard the land which they control. This, however, is not the case due to financial limitations and, more often than not, poor land management practices. To farmers, the agricultural industry is a business in which many years, and hundreds of thousands of dollars has been invested. Like all businesses,

the goal is to get as much return out of the investment as possible. Unfortunately, in the quest for financial renumeration, good soil management practices are often by-passed.

A prime example of this, and indeed almost the sole villian of soil erosion, is the practice of summer fallow. A summer fallow field is one that lies bare without cover for a period of time (generally a year) and is tilled several times in the course of the year. Uncovered, and exposed to the elements, this field is highly susceptible to moisture loss due to evaporation, and the whole cycle of events that lead to eventual drifting. (Figure 7)

The decision to summer fallow may be the result of many factors of combinations of factors. The Environmental Council of Alberta (ECA) in their 1982 report summary outline several major reasons for summer fallowing. First, agroclimatic factors which consider the microclimate of the soil are geared at preserving soil moisture. In theory, by summer fallowing, weeds which compete for soil moisture are controlled through tillage (environmental Views, 1986). While this practice may be used with moderate success in Northeast and Central Alberta where adequate rainfall is received, in Southern Alberta summer fallowing leads to a decline in soil quality due to the removal of organic matter and topsoil by the wind. The extent and severity of soil erosion has not been adequately documented, therefore it is difficult to estimate the damage to date in terms of actual dollars lost.

FIGURE 7. LOCATION: 15km east of Granum on Highway 519.
Soil blown from the fallow field is deposited within the bushes and along the highway. The shelterbelt was grown to protect the house situated within instead of the field. Note the large rocks that have been exposed.

But, according to Agriculture Canada's 1984 report, it is estimated that the costs of erosion are in excess of 7% of the total value of crop production in Alberta. (Agriculture Canada, 1984)

Government policies may have been a factor considered in summer fallowing back in 1971 since the "Low Inventories for Tomorrow" (LIFT) Program encouraged farmers to reduce their yield by paying an incentive of $6.00 for each acre of summer fallow instead of wheat. Today, programs are geared more toward conservation, as in the Soil Conservation Program. The purpose of this program is to assist farmers battling erosion by offering advice, information, and financial assistance. Albertans also have the Soil Conservation Act which states in Section 4 that:

"Every person who owns, occupies or controls land:

a) shall take active measures to prevent soil deterioration on the land by the action of wind of water or by any other cause"

Although this Act attempts to preserve the agricultural land base, enforcing the regulations is very difficult since economic conditions coupled with the farmers' financial situations may be such that they cannot afford to modify their practices. Furthermore, it is highly likely that many farmers are not even aware of the Act.

Other considerations which lead to summer fallowing include the current economic and market opportunities. Input costs have to be compared to the

price of the product on the market. If the grain is not economical to grow, either an alternate crop is chosen or the field is left fallow. Similarily, if grain quotas have been fulfilled, farmers must either diversify or allow their fields to lay fallow.

A few variations exist in the use of summer fallow, and there are also several alternatives which should be considered. These measures which include utilizing trash cover, strip farming, cover crops, rotating crops, and providing shelter belts could help to prevent degradation, or at least limit its extent.

Trash cover farming is the practice of leaving stubble on the field once the crop has been harvested. The effect of this stubble is to reduce the velocity of the wind near the soil surface, to trap and settle any moving soil particles, to trap precipitation, and to provide insulation to the soil both from excessive heat and bitter cold.

The effectiveness of the stubble is dependent on the height to which the stubble was cut. If too short, the shortwave radiation from the sun can still penetrate to the ground heating the surface and increasing soil moisture loss through evaporation. The zone of reduced wind velocity will be closer to the soil surface therefore, increasing the probability of drifting. If the stubble is too high, there is the risk that any inputs of precipitation will be trapped by the standing stalks and its arrival to the

soil surface will be delayed. This lag time increases the amount of evaporation which could occur and hence could rob the soil of incoming moisture. The latter scenario is the less critical of the two. The advantage of a higher stubble is that it protects from wind velocities which are also high.

Instead of leaving stubble, another alternative is to spread flattened trash on the surface and lightly plowing it into the top layer of soil. The flattened trash may consist of residues from crops such as flax, mustard, rape or sunflower, but the more effective residues come from cereal crops. The method of utilizing flattened stubble would be effective in light winds, but would have difficulty standing up to the intense chinooks often experienced in Southern Alberta.

A third often used practice is that of strip cropping and involves alternating narrow fields of summer fallow with narrow cropped fields. This can be effective because the cropped field localizes the drifting which may start in the summer fallow, and also because the distance the wind has to travel across the exposed soil is reduced. Unfortunately, this practice still utilizes summer fallowing and in those regions where wind is prevalent, strip cropping still leads to erosion. In areas where strip cropping is recommended, it need only be remembered that the strips should be at right angles to the prevailing wind, and that the most effective width varies with soil texture, the prevalence of high winds, and the extent of erosion.

Cover crops are those which are grown on summer fallow to ensure that the soil is covered. Not only does such a practice control soil degradation by drifting, but the field produces a crop which could later be used as fall pasture for foraging animals.

Cover crops can be utilized in crop rotations as well. Crop rotations ensure that soil nutrients are replaced by alternating the type of crop which is grown on the particular parcel of land. Allowing a field to support only one type of crop depletes nutrients rapidly especially those most used by the particular crop. Allowing a field to lie fallow, to "rest", instead of growing other corps on it is not very effective since the field would just be subject to more erosion. Before utilizing the method of rotating crops, however, farmers should consult with their local authorities since some soils cannot support the practice.

Another erosion-reducing practice is the employment of shelterbelts. They are effective in reducing the velocity of the wind since they act as partial barriers. Though it may seem logical to assume that the thicker the shelterbelt, the more effective it is in reducing wind velocity, this is only true to a point. Once the shelterbelt is so dense that the wind cannot blow <u>through</u> it, the wind must go <u>overtop</u>.

Hence, the velocity on the leeward side may actually increase, and the resulting eddies created by the stand could actually make the erosion

greater! Diagram 2 illustrates this point.

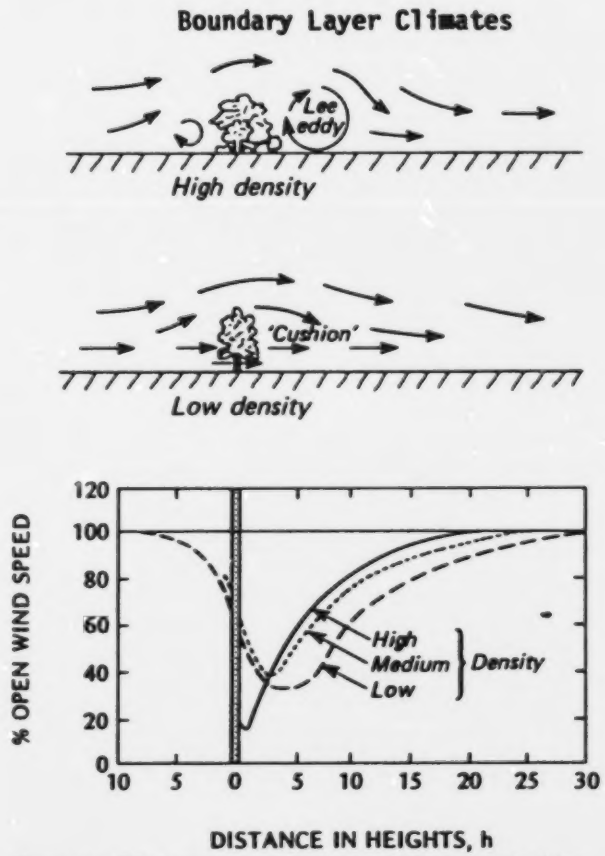


Figure 7.7 Wind speed reduction in the vicinity of shelterbelts with different densities (after Nägeli, 1946).

Source: Ike, 1978, p. 214

The dense windbreak actually creates a bottleneck through which the same volume of air must pass. Analogous to a stream of water, when flowing in a wide channel, the flow is slow; however, when the same quantity of water is forced to flow through a narrow channel, the velocity is increased.

On a bare, fallowed field, once drifting has begun, there are several emergency measures which may be employed to reduce the severity of the damage: manure or straw may be applied to the drifting surface, the straw lightly disced into the soil; a chisel may be run through the soil to produce a cloddy surface in an attempt to reduce the velocity of the wind at the air-soil interface; deeper furrows may be produced with cloddy soil thrown over the ridges of the furrows not only to reduce wind velocity, but also in an attempt to protect the drier surface soil by covering it with moister clods. These "last ditch" efforts only limit the amount of damage slightly, and a prolonged intense wind could not be effectively protected against.

There do exist soil management practices which never expose the soil directly to the wind and therefore would be quite safe to use in areas prone to drifting. One such approach is zero tillage in which the crop residue is left behind in the form of stubble, and is only disturbed through seeding. (Environmental Views, 1986) Weeds are controlled through the application of herbicides. Another effective control of drifting is the application of reduced tillage in which the remaining crop stubble is very lightly tilled into the soil such that a significant portion of the residue is still on the surface. The soil surface is then sprayed with herbicides to control the growth of weeds. In the event that the farmer wishes to leave his field uncropped for a year, instead of plowing the soil to destroy the weeds, the field is sprayed with chemicals and the soil surface left stable. This practice is referred to as chemical fallow.

The only drawbacks to these approaches are that, first, too many added chemicals are undesirable, and second, the cost of repeated pesticide spraying is uneconomical. The application of large amounts of pesticides can create costs that are 10% higher than the more traditional methods of cultivation. (Environmental Views, 1986) However, by leaving the stubble on the field, not only is the organic soil matter retained, but fertilizers do not need to be applied to as great an extent. In standard fields, the removal of the entire crop results in depletion of those nutrients which the crop has absorbed. By retaining the stubble on the field, the nutrients can be re-introduced to the soil by the simple process of organic decay.

According to a recent Farming for the Future study "Zero tillage versus minimum tillage trial" by B.J. Knott near Stavely, in the fourth year of the study, the zero till field began to show better than the minimum till field. Differences, however, were shown to be not significant and more years of study are needed into the area.

The positive effects of reduced or zero tillage will not show themselves quickly, as it will take many years for the soil to return to a balanced fertile state, and therefore for bumper crops to be realized. As stated earlier, for farmers who treat the farm as a business, it is too much of a burden to employ those practices which require increased input costs. As one farmer has been quoted saying, "If you do a wonderful job of soil conservation and you go broke, you've lost everything -- it certainly hasn't

helped you." (Environmental Views, 1986, p. 20)

John Kolkman, a research and policy co-ordinator for the Christian Federation of Farmers, was quoted in Environmental Views saying that " if we don't manage our soil well and we let it degrade over time, we're going to have to spend ever increasing amounts of money to make up for what's not there -- more fertilizers, more money to move water, the costs of erosion both in soil loss and in clearing out culverts and silty rivers." (Environmental Views, 1986, p. 19) Essentillay, we are playing against time, and if conservation measures are not encouraged soon with much more vigour than in the past, we may end up losing our land base.

A field in Southern Alberta on the Peigan Indian Reserve, just west of Fort McLeod, illustrates very clearly the critical nature of the problem. The soil has been eroded to such an extent that it no longer looks like soil, but rather like desert sand shifting easily in the wind. (Figures 8 - 17) In places, the field consists of hummocks of dried grass trapped behind the ridges. Elsewhere, the rocks so stud the surface that the field more closely resembles a potential gravel pit. The cost to replace the fertility of such fields is beyond estimation; the time required to do so could well exceed the lifetime of its present owners.

Unfortunately, what is still needed is more research into soil management for the Southern Alberta region, and indeed for most soils

FIGURE 8. LOCATION: Peigan Indian Reserve, 4km west of Fort McLeod on Highway 3.
Soil no longer resembles soil, but rather sand. Hummocks are large and clearly visible from the roadside.

FIGURE 9. LOCATION: As above.
A close up of Fig. 8 shows the dunes of sandy soil. Photo is looking west.

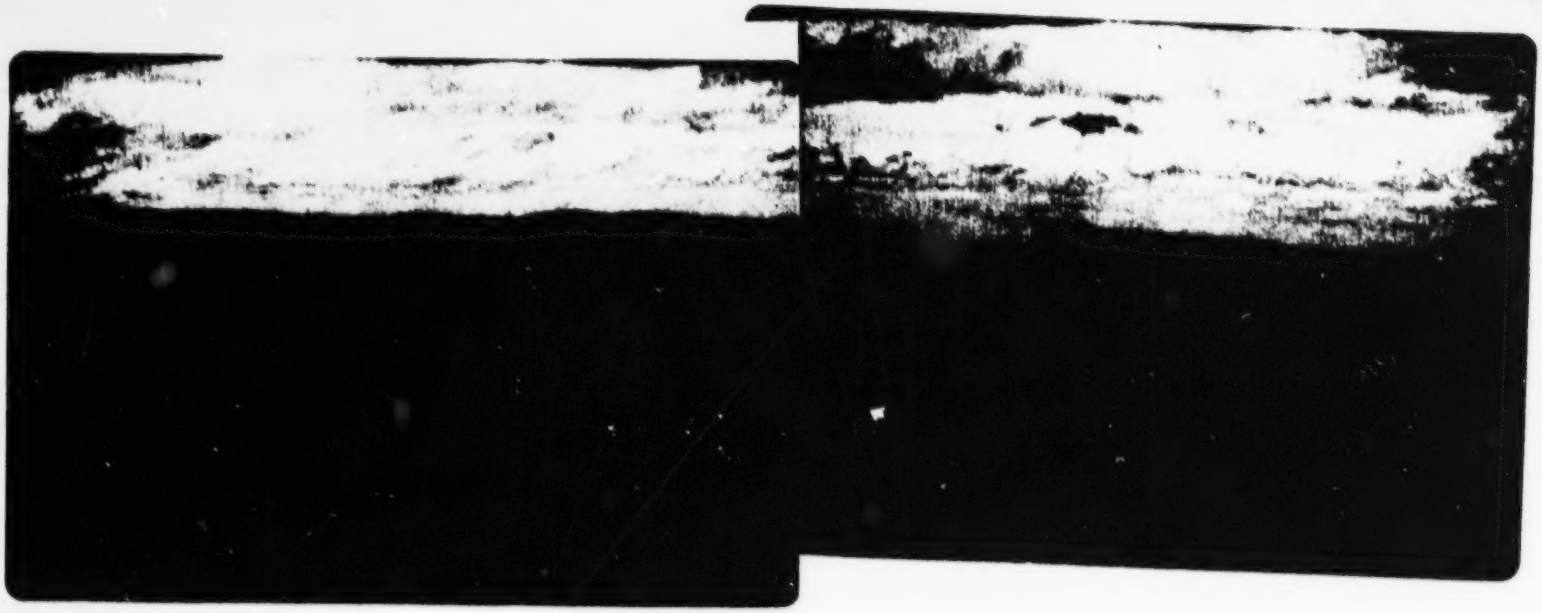


FIGURE 10. (above) LOCATION: Peigan Reserve Photo is looking north. Note the extensive longitudinal dunes built up behind fence posts.

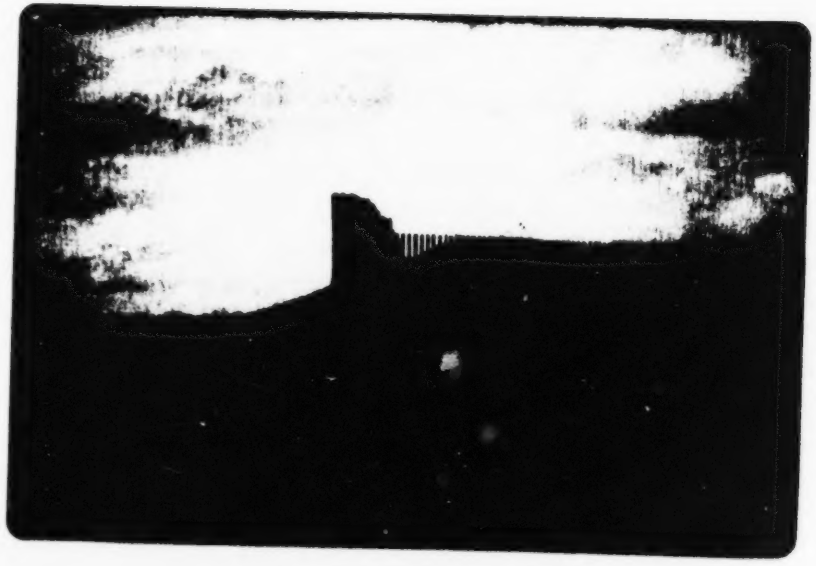


FIGURE 11. LOCATION: As above Close up of snow fence illustrates depth of deposition. Color differences between Fig. 10 and 11 are due to the use of different lenses. Fig. 10 shows true color.

FIGURE 12.

LOCATION: Peigan Reserve

FIGURE 13.

Note the extent of the deposition along the highway in all three photos.

FIGURE 14.

FIGURE 15. LOCATION: Peigan Reserve
Ditch is filled with sediment from adjoining fields. At this site, several adjoining fields were left fallow which intensified the effects of erosion.

FIGURE 16. LOCATION: As above.
Gravel surface looks as though it could be mined.

FIGURE 17. LOCATION: Peigan Reserve.

FIGURE 18. LOCATION: As above

Huge piles of soil are trapped behind fences. The tumbleweeds held by the barbed wire fence act as windbreaks. Note the depth and the extent of the deposition.

experiencing degradation. Until we can offer the solution to halt continuing erosion, or to prevent erosion from starting in the first place we must make due with the guidelines in place. "No one really knows what form or forms of soil management will work best," (Environment Views, 1986, p. 20) and we are running out of time to find these techniques.

So much is missing from our precious vault of information: map based data depicting the extent of land degradation for Western Canada is unavailable (Anderson, et al, 1984, p. 6); maps depicting the extent of severely or partially eroded lands are not available (Anderson, et al, 1984, p. 6); actual effects of reduced soil productivity on yields (assuming no compensating inputs on different types of soil) is not known (Anderson, et al, 1984, p. 42). We need to fill in these gaps in our information banks. We need to acknowledge that Southern Alberta has a definite wind erosion problem, and that summer fallowing is not a proper management practice under chinook conditions. We need the funding and the support of decision-makers to seriously tackle the problem. We can no longer afford to keep our heads in the sand and refuse to admit that there is a problem. "Unless we spend the money and find the right methods of soil management for Alberta, there's always a chance that...Canada's prairie bread basket could become a 21st-century desert." (Environmental Views, 1986, p. 20)

Which will it be?

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